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ABSTRACT

A study was conducted to inquire into serial and parallel relations of information processing. A hypothesis was derived from earlier studies, and it was assumed that serial processing exceeds parallel processing in time. A figure-type test was constructed with two items. The reliability of the measure was examined with the coefficient of alienation against a random criterion. Validity of the measure was examined with the goodness of fit of the relation structures. The subjects were 96 secondary comprehensive school students in Finland, and they were divided into 13-, 14-, 15-, and 16-year-old age groups. The analysis of processing consisted of a base line definition and the eigensystem solutions in each age group and between them. The results indicate a slight corróboration of the hypothesis with some exceptions. Thus the process of serial and parallel processing emphasizes the development of the control part or of the serial processing during time. A didactical process application was shown from the basis of the findings, and some shortcomings of educational theory construction are expressed. (Contains four tables, two figures, and two references.) (Author/SLD)

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ED 418 137

On Serial and Parallel Processing Relations of Mindies from an Educational Point of View

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Abstract

The purpose of the study was to inquire the serial and parallel relations of information processing. The relations were defined as processing. A hypothesis was derived from an earlier result and it was assumed the serial processing exceeds the parallel one in time. A figure type test was constructed with two items. The reliability of the measure was examined with the coefficient of alienation against a random criterium. Validity of the measure was examined with the goodness of fit of the relation structures. The subjects were 96 secondary comprehensive school pupils and the total number of the subjects differentiated between four age groups, 13, 14, 15, and 16 years old. The analysis of processing consisted of a base line defintion and the eigensystem solutions in each age group and between them. The results indicated a slight corroboration of the hypothesis with some exceptions. Thus the process of serial and parallel processing emphasizes on the development of the control part or of the serial processing during time. A didactical process application was shown from the basis of the finding and some shortcomings of educational theory construction were expressed.

On Serial and Parallel Processing Relations of Mindies from an Educational Point of View

The objective of the study is to inquire relations between serial and parallel processing of information. The study is of relations or more formally expressed a R b. It is the R:s that are the object of the study and the R:s are serial or parallel. The study is a parallel one and joins with other studies that deal with the emergence of mental shape and mindies or units of mind (Laasonen 1993a, Laasonen 1993b). This time the a:s and b:s drop and I concentrate on the relation processes or the R:s. What is the motivation behind the study? There are several reasons to warrant to study the problem.

During the 20 years I have been working on the different levels of Finnish educational systems which have the nature of conserving the achievements of other generations I have made some perceptions. The first one is instruction bases on the different beliefs the teachers have about learning. The second one is the dynamism of schooling system is on the conceptual level, plainly. The third perception includes the detail the learning theories are on the level of the Ebbinghausian era. It is not a

surprise that the administrational zombies of school system try to maintain status quo because of the laws of avidity and least effort. The fourth aspect joins with teacher education that is considered qualitatively high although no readinesses are taught for shuttling among the pupils. Evidently the only quality taught is the means of immediate submission and to make a noise. Against this ground it is reasonable to fade some prejudices and beliefs concerning education.

The knowledge of serial and parallel of processing information has far reaching consequences because it affects objectives, means, and especially the implementation of instruction and education in real settings. The objectives are in curriculums. The means include methods of teaching, and the implementation, the most difficult phase, includes behavior where the things are managed as they should be. The should be cases are easy to produce because the normative aspect does not contain the fact, how the things are. It is easy to sit down and write how the things should be. In fact, the knowledge of the serial and parallel relations makes it impossible to stagnate in certain states of educational dynamics because of continuous

flow of information. Naturally, to draw fine flowcharts is a joy but the real benefit from the knowledge of serial and parallel processing comes to the implementation because the educational situations organize according to that knowledge. A result in a study of a mindy or of a unit of mind indicates the serial processing is the regulation part and the parallel one makes the proper processing of information (Laasonen, 1993b). So it is reasonable to concentrate on the control part that organizes environmental information. The deduction is: It is better to pay attention on the arrangement of education than mere doing.

The corollary, in the form of a hypothesis, is information processing forms a control process where the serial processing becomes more powerful with parallel processing in the studied time interval.

Especially, the sets of relations mean processes or R = a relation process. On the other hand, there is general knowledge persons settle down their mind processes into certain tracks which are resistance to modifications. Thus the prevailing mode

of thinking are conservative and emphases former experience, usually applied to new educational situations, erratically. So it is consistent to assume the serial processing becomes more important during development because it is responsible for the action of the parallel processing. There emerges crystallization of regulation.

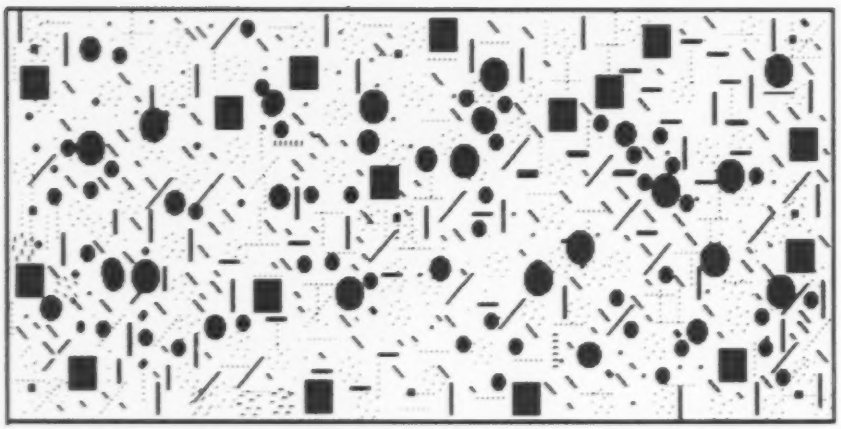
On the other side of the implementation is theoretical fertility of the study. The expectation is results are able to delete vain figurative coils that are hindrances for theoretical construction of educational theory and praxis. Two variables are analyzed: the serial processing of information and the parallel processing one.

Method

Test Construction

The constructed test included two items that based on a matrix arrangement because the serial processing takes place along the rows and the parallel processing along the columns. The first item is a type of searches and finds (Figure 1). The second item is of an ordering type (Figure 2).

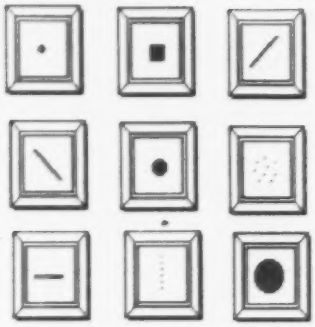
Insert Figure 1 about here

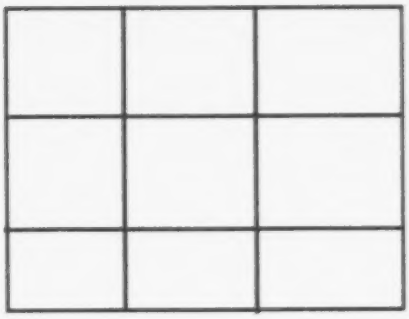


There are nine small squares (▪) camouflaged in other forms in Figure 1. The squares locate in a 3 by 3 matrix. The instruction for a subject was: There are this kind of hidden squares in the figure below (▪). Your task is to find the squares, circle them, and mark them 1, 2,... in the order of finding them. The number is put beside the circled square. This kind of arrangement made it possible to verify the serial and parallel processing which the order of finding indicates.

Insert Figure 2 about here

The second item contains forms in the left side of Figure 2. The purpose was that the figures are to put into the 9 nine frames on the right side in order. The instruction of the second item was: There is a set of modern paintings below on the left that have become in disorder. Your task is to put the paintings to the right order in the frames next to drawing the figure of the paintings in the right square. The drawing begins from the right upper corner. In this way it was possible to verify how the subjects cruise between the frames.





Subjects and Data Gathering

The subjects were pupils of a secondary comprehensive school from the same school district. The total number of the subjects was 96 but the number differentiated among 4 groups 13 years (n = 19), 14 years (n = 35), 15 years (n = 31), and 16 (n = 11) years old groups. The differentiation was performed because of the dynamic approach to the problem.

Data were gathered during the lessons and the performance of the test lasted about from 10 to 15 minutes. No disturbances or interruptions existed during the testing and "rapport" was good.

Results

The orders that the subjects indicated in the first item, scored in a reverse order. The manner is common in preferential type of measures such as in sociometry. The "paintings" on the left in Figure 2 were row numbered from 1 to 9 and the orders of the figures were replaced with the ordinal numbers. The orders of the second item were scored in a reverse order, too. The procedure resulted in two 3 by 3 matrices for each subject who had a one-to-one correspondence with the ordering of the squares and of the "paintings." The scored matrices were added

together in the age groups. This resulted in the sum score matrices. However, the relation processes were not verified from the sum score matrices but the images, only. So it was necessary to construct cumulative matrices. The cumulative procedure was performed in a descending order that started from the greatest sum score. The procedure made it possible to follow up the serial and parallel processing in the sets of relations. The cumulative matrices are in Table 1.

Insert Table 1 about here

Reliability and Validity of Test

The novelty of a test made it necessary to assess the qualities. The manner chosen here differs somewhat from the usual means to assess reliability. First, a random order matrix was produced. Twenty-seven pseudorandom numbers were produced in the interval from 1 to 9. After which a fifty-fifty randomization was applied to the queue of the pseudorandom numbers. If the randomization of the queue produced 1 then the number included in the random order matrix. The procedure resulted numbers from 1 to 9. The scoring was the same as in the

Table 1

Cumulative Matrices of Items in Age Groups

	Item 1			Item 2		
Age Group						
13	138	446	537	587	677	208
	243	701	775	106	764	305
	347	446	621	401	677	496
14	240	444	827	212	793	605
	646	1316	1454	1134	1572	414
	1007	1166	1582	1438	1299	966
15	232	948	1413	179	1133	354
	447	1083	1311	520	1407	988
	650	800	1201	1272	835	679
16	90	292	343	81	316	404
	168	434	514	145	362	207
	233	390	477	265	362	444

empirical case. The reliability of a test is an ability of a test to resist randomness. That is why match or point by point correlation was calculated between the random matrix and the age group matrices of the items. No significant correlations existed with the limit value $r(7)=0.582$, $p<.10$. The coefficients are in Table 2.

Insert Table 2 about here

From Table 2 it one can verify the proportion of randomness in the measures is minimal. The calculation of coefficients of alienation produced rather high values which imply high reliability as indicated in Table 2.

Validity was examined during the proper analysis. In this context, validity examination consisted of joining with two items of different type. Then one could deduce whether the items measure the same qualities. What they are to measure. Before starting the analysis of validity and the relation processes it was necessary to define base lines for serial and parallel processing. That was implemented with the help of the means of the subject

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Table 2

Correlations and Their Squares of Random and Empirical Matrices, and Coefficients of Alienation

	Item 1		Item 2	
Age Group	r_{ij}	r_{ij}^2	r_{ij}	r_{ij}^2
13	.31	.09	.14	.01
14	.10	.01	.00	.00
15	.22	.04	.41	.16
16	.17	.02	.14	.01

Coefficients of Alienation

	Item 1	Item 2
Age Group		
13	.95	.99
14	.99	1.00
15	.97	.91
16	.98	.99

matrices. The mean score of one subject matrix was 5. A 3 by 3 matrix of fives was constructed and it functioned as a base line because the matrix does not give possibilities to infer serial or parallel processing. The neutral matrix was multiplied by the number of the subjects of every age group. Next, the values of the outcome matrices added in the rows and in the columns, cumulatively. The action resulted in the base line matrices for the serial and parallel processing. The empirical cumulative matrices were row and column subtracted from the base line matrices in each age group. The procedure resulted in the deviation matrices from the pure serial and parallel matrices. The deviations were converted into z-scores. The z-scores were squared because of the matter of convenience. It is easier to deal with positive numbers and the relationships between the values do not change. Thereafter the squared values were row and column normalized in the items in the age groups.

A product of $\underline{aa'}$ of the row and column matrices was produced. The applied matrix program gives a possibility to deal with the columns as rows so there is no worry about the erroneous multiplication. The postmultiplication of the normalized matrices resulted

in squares matrices of cosines. The sums of the squared deviations were calculated between the row matrices and the column matrices of cosines of the items (serial-serial, parallel-parallel) to verify the goodness of fit between the matrices for joining the items. The obtained values turned into percentages from the maximum fit. The mean percentage is 9.33 from the maximum one over the age groups and serial and parallel values. The more detailed values of the age groups are in Table 3.

Insert Table 3 about here

The values of Table 3 are for the thing the items can be joined for dynamics of the information processing analysis.

Information Relation Processes

The results of the validity analysis allowed the joining of the items. However, it was not necessary to join the original cumulative matrices but the proper deviation matrices in the manner of row by row and column by column. The deviation matrices were added and squared. After which the joined deviation matrices were row and column normalized. The scalar products of the

Table 3

Sums of Squared Deviations between Items in Age Groups and Their Percentages from Maximum

Age group	Serial-Serial	Parallel-Parallel
	Absolute Values	
13	.32	.89
14	.01	1.28
15	.82	1.43
16	.05	1.57
	Percentages	
13	3.5 %	9 %
14	0.1 %	14 %
15	9 %	15 %
16	0.5%	17 %

Note. The overall sum of maximum deviations is 72; the individual sums are 9

normalized matrices were formed that resulted in square cosine matrices. The cosine matrices were squared because the squares indicate the common associations between the variables, in separate for serial and parallel processing. The squared matrices were row and column normalized, again. Thus there formed serial and parallel matrices for the relation processes where the normalized squared cosines are the relations as the elements in the age groups.

To have the whole dynamics in the interval of 13-16 years it was necessary to define the process in time order. Thus the differentiation of time included 13 years, from 13 to 14 years, 14 years, from 14 to 15 years, 15 years, from 15 to 16 years, and 16 years of aged. The intermediate phases are transitions from age to age.

The stressing of the serial and parallel processing demanded four matrix multiplications (a) horizontally, serial-parallel (b) vertically, serial-serial in time (c) vertically, parallel-parallel in time (d) vertically, serial-parallel in time.

The above kind of arrangement of the worked through data made it possible to study the information processing in the cases of serial and parallel and

serial or parallel. To find out whether there is something regular in dynamics, the eigensystem solution was selected the analysis for the phases in time. The eigenvalues and the eigenvectors were calculated in the age groups and in the transitions. There proved to be only one eigenvalue and its vector in each phase that can be verified in Table 4.

Insert Table 4 about here

The glance on Table 4 reveals a certain kind of regularity exists in dynamism.

Discussion

The hypothesis corroborates slightly, although there is alternation between serial and parallel processing during the time span. Let me remind the question of the study is to find relations that are processes in the development of human information processing. The images are not essential in this context. Before the interpretation of the results in Table 4 it is adequate to make a conceptual clarification. The first clarification concerns the meanings of the

Table 4

Eigensystems of Serial and Parallel, Serial or Parallel Information Relation Processes

Age	Serial Eigenvalues	Serial-Parallel Eigenvalues	Parallel Eigenvalues
13	2.51	2.33	2.23
13-14	2.41	5.25	2.24
14	2.33	2.27	2.27
14-15	2.56	4.96	1.96
15	2.85	2.19	1.97
15-16	2.25	4.21	1.88
16	1.84	1.94	2.19

Eigenvectors

Age	Serial	Serial-Parallel	Parallel
13	[.60.60.51]	[.57.57.57]	[.57.52.63]
13-14	[-.61-.60-.51]	[.58.57.57]	[.55.56.61]
14	[-.64-.58-.49]	[.63.56.54]	[.54.60.58]
14-15	[-.63-.61-.51]	[.62.55.54]	[-.58-.53-.60]
15	[.58.57.56]	[.57.56.59]	[-.70-.09-.70]
15-16	[-.58-.58-.55]	[.57.56.58]	[-.61-.48-.62]
16	[.63.68.36]	[.51.64.56]	[-.41-.63.-64]

eigenvalues and vectors. Moving down the eigenvalue columns in Table 4 indicates a decrease of the values. Transferring along the rows shows about similarity in the values of the eigenvectors. There emerge dilatations in the eigensystems that can be verified with the multiplication of the eigenvalues and vectors.

The about similarity in the rows warrants to call the invariant vector mode of information processing To give a meaning to the eigenvalues is a more complex task but the variety among the lambdas warrants to call them as modulators of information processing The other thing concerns the inverse relation of serial and parallel processing. Thus the negative mode of serial processing is parallel in reality.

The simultaneous moving downwards along the age in Table 4 produces dynamism of information processing with the events.

In the age of 13 years the serial and parallel modes of information processing are about equal which means incoming information is dealt with in a both-and manner. The modulators steer the modes in about same intensity. In the transition from 13 to 14 years the mode of processing turns into a parallel one powerfully

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and the modulation of the parallel mode steering is intensive. The same state of affairs continues in the age of 14, except the modulator weakens its steering action. There takes place a reversal between the serial and parallel modes and the parallel one is slightly dominant from 14 to 15 years of age. The modulator steers the reversal rather powerfully. In the age of 15 the serial mode becomes clearly dominant, although the steering is not very intensive. From 15 years of age to 16 years a reversal again emerges and the parallel mode is slightly dominant. The steering function of the modulator is weaker than before. In the age of 16 the serial mode becomes dominant but the steering modulation weakens. So there is no need for the continuous steering of the serial mode because of its preferred priority.

Examination of the entire process indicates the information processing continues from the two-directional steering processing through the parallel modes to the serial processing and drops by in the parallel mode before settling down to the serial mode. The intensive regulation of the modulators places in those phases of the process where the transitions take place. Evidently, in the still water places it is not

necessary to modulate the already settled mode but in the changing phases the steering of the direction of serial or parallel mode is profitable to avoid the Buridan ass behavior.

I cannot avoid to consider the evaluation of one's own contribution to be self-satisfied because time is the best evaluator for scientific enterprises. Instead, I can state the original problem was solved, roughly. Although deviations exist from the hypothesis the trend is for transferring from the parallel processing mode to the serial one.

The finding has implications to many directions. One of them deals with educational theory construction. Natural is, there is great variety in the group of same age young persons but according to my knowledge the information processing aspects have not received consideration in educational theory construction. However, the knowledge of the mode changes of information processing has a focal place because it affects the whole didactic and education. For example, the mode of processing influences in setting objectives because the objectives include the approach of instruction and the method. Although, the finding is not of general meaning against the ground of sampling

statistics, something comes in sight from the finding.

Application of the finding to the triplet, ends or goals, means or methods, and implementation or action in reality produces a kind of a theoretical entity.

The didactical goals can include serial or parallel mode of processing for 13 years old and probably for the younger ones because the young ones of the age deal with information in a both- and manner. An instructor can teach one thing continuously or some things simultaneously with comparison. In implementation, for example, in geography one country can be taught thoroughly or two or three countries can be taught simultaneously through juxtaposition. Simply put, the pupils can acquire details from various countries put them side by side on a paper, the same things in the same rows. The other alternative is to work through a country and to write down the details and to put photos or other material on an individual paper. Probably, the outcome of information adoption is the same.

The same arrangement does not apply when the young ones transfer from 13-14 years old and are 14 years old. The sentences of the didactical goals

include the parallel mode of processing information because the modulator steers the mode powerfully. The contents of the subject matters can be presented in the way the things are juxtaposed that are to be taught in parallel. The method demands the subject material is in the form of a newspaper page, for example, with two to three columns. It makes possible comparisons and connections. For example in the implementation of instruction languages, the Finnish case forms can be put one below the other in a column and the prepositions and postpositions of English and Swedish correspondingly into the other two columns. In this way it is possible to verify the one-to-one mappings between the lingual correspondences. It is an unfortunate situation when content of a subject matter is processed in the parallel mode and teaching is serial.

In the next transition from 14 to 15 years the reversal of the modes and the slight dominance of the parallel mode speaks for the fact the serial presentation completes the parallel on. Thus the didactical objectives include the priority of presentation the contents of subject matter side by side and after that the same thing sequentially.

In geography it means comparison of countries and

thereafter a thorough teaching of one country after another. Implementing the operations realizes by listing the similarities of the countries. For example, the Scandinavian countries are put side by side and after that the countries sequentially.

In the age of 15 the serial mode is dominant and there is no need for juxtaposition, side by side arrangements, or column page presentations. The matters can be taught sequentially, one at a time. The didactical wholeness is the one used usually in teaching.

In the transition the same behavior applies as in the transition from 14 to 15 years because of the similarity of the modes of processing and of steering.

In the same way instruction for the 16 years old can be arranged as for the fifteen years old because the serial processing is the prevailing one. As an entity the chain of events in the process goes towards the dynamic control of information than towards the working parallel processing. It probably does not develop much after 16 years but one can assume the control processing increases and settles down to certain tracks based on former experience and having the conservative nature. The fact does not promise much for dynamic behavior and urge for the

construction of better education.

Conserving the achievements and developments of others is much easier than to adopt dynamic angles of view. The output from the boned views produces society zombies who do not see anything to develop but accept the prevailing conditions and reason the circumstances according to the adopted autostereotypes, ethnocentricly.

Taking a more theoretical stance I verify the finding refers to the direction that the value loaded premises of educational theory construction need reevaluation because information processing of persons and the ways of doing it is a focal point to behavior. Somehow, there remains an impression educational theory construction and the underlying values originate somewhere else than from human beings and our limited capacity to cope with environment. The study, however, shows the axiomatic approach is to encompass operators that originate from human beings because of the boundary conditions which evolution has produced for the benefit of persons. Learning is a matter of education, adoption of knowledge is a matter of evolution.

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Figure Captions

Figure 1. Item 1.

Figure 2. Item 2.

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